Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

ORIGINAL

In the Matter of	)	
	)	
Amendment of Parts 2 and 25 of the	)	ET Docket No. 98-206
Commission's Rules to Permit Operation	)	
Of NGSO FSS Systems Co-Frequency with	)	
GSO and Terrestrial Systems in the Ku-Band	)	
Frequency Range	)	

COMMENTS OF PANAMSAT CORPORATION

PANAMSAT CORPORATION

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In these comments, PanAmSat Corporation ("PanAmSat") responds to the Public Notice (the "PN") released by the Commission on December 6, 1999, in which the Office of Engineering and Technology and the International Bureau requested additional comments on the conclusions reached by the Conference Preparatory Meeting (the "CPM") in Geneva, Switzerland regarding spectrum sharing between Non-geostationary Satellite Orbit ("NGSO") and Geostationary Satellite Orbit ("GSO") Fixed Satellite Service ("FSS") operations.[1]

As the PN notes, both PanAmSat and SkyBridge LLC ("SkyBridge") filed *ex parte* comments shortly after the adoption of the CPM report. The comments submitted today expand upon PanAmSat's earlier *ex parte* filing, addressing the specific topics on which the PN requested comment. This pleading, therefore, should be treated as superseding PanAmSat's December 6th submission.

These comments also respond to SkyBridge's December 3rd *ex parte* filing, in which SkyBridge provided for the record a large number of submissions to and outputs of the various ITU-R study groups reflecting the position of the NGSO interests, including documents dating back to the period immediately

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1 "FCC Seeks Comment on NGSO FSS Results from the Conference Preparatory Meeting on Technical, Operational and Regulatory/Procedural Matters To Be

following WRC-97. SkyBridge's submission makes it necessary for PanAmSat to balance the record by submitting a parallel (in terms of time and scope) set of submissions to and outputs of the ITU-R study groups that reflect the concerns of GSO operators and users. This augmentation of the record will ensure that the Commission has before it a complete technical record reflecting equally the positions of the GSO and NGSO industries.[2]

I. BACKGROUND AND SUMMARY.

PanAmSat reluctantly accepts but fully supports the compromise reached within the CPM and recommends that the Commission use the compromise as the basis for its domestic regulations.

While the CPM's compromise is an important achievement and should form the basis for U.S. domestic regulations, the PN recognizes a crucial fact: the CPM's recommendations are not self-enforcing and cannot take the place of meaningful domestic regulations. If the Commission is to achieve its goal in this proceeding - *i.e.*, to develop technical and operational rules that permit NGSO FSS systems to use GSO FSS Ku-band frequencies while protecting existing and future GSO FSS services from unacceptable interference[3] - it must adopt and enforce domestic licensing, technical, and service rules that meaningfully implement the CPM standards and that provide prompt, effective remedies for

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Considered by the 2000 World Radiocommunication Conference," DA 99-2733 (rel. Dec. 6, 1999).

[2] A list of the documents being submitted is contained in Appendix 1. For the convenience of the Commission's staff, all documents that are available in electronic form have been included on a CD-ROM, which is being provided to the staff. Documents not available in electronic form are so noted. While some of these documents previously have been submitted in this proceeding, PanAmSat believes that providing a single, comprehensive submission containing all relevant documents will make it easier for the staff and interested parties to locate relevant documents.

[3] *Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range*, Notice of Proposed Rulemaking, 18 FCC Rcd 1131, ¶¶ 1, 9 (1998) ("*Ku-Band GSO/NGSO Sharing NPRM*").

any violations that may occur.[4] As so often is the case in transforming general principles into enforceable regulations, the devil will be in the details.

These comments provide an overview of the technical issues presented by NGSO operations in GSO spectrum, followed by recommendations for how the Commission should implement the CPM compromise. In addition, as discussed above and as set forth in Appendix 1, PanAmSat is providing a set of documents to supplement the record of this proceeding.

PanAmSat notes that this docket does not reach, and the PN therefore does not solicit comments regarding, NGSO/GSO sharing in the Ka-band. As PanAmSat has discussed in prior filings addressing NGSO Ka-band applications, the sharing considerations in the Ka-band are fundamentally different from those present in the Ku-band, primarily because the Commission has adopted a band-sharing plan for the Ka-band that makes NGSO systems primary in some portions of the band and secondary in others. As a result, the Commission should not attempt to use the rules proposed by PanAmSat herein as the basis for resolving Ka-band NGSO/GSO sharing issues.

II. UNDERSTANDING THE CPM REPORT: KEY TECHNICAL ISSUES ASSOCIATED WITH NGSO USE OF GSO FSS SPECTRUM.

To a regrettable extent, during the past two-and-one-half years political considerations frequently have overshadowed the underlying technical

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[4] As PanAmSat has discussed in previous filings, licensing should occur only after sharing rules have been adopted, each NGSO applicant has demonstrated its ability to comply, in operation, with those rules, and these demonstrations have been subjected to public comment. The CPM's conclusions make it particularly important that the Commission follow this process and refuse to expedite the licensing of a selected system or systems: Because the CPM decided not to adopt a specific number of GSO systems but, rather, to consider individual system characteristics in assessing compliance with aggregate NGSO limits, it is not possible to establish whether mutual exclusivity exists until the Commission has determined which of the applicants are legally, technically, and financially qualified to launch and operate their proposed systems, and has reviewed the technical characteristics of each such system.

principles associated with NGSO/GSO spectrum sharing. PanAmSat hopes that the results of the CPM will bring an end to this state of affairs, allowing the Commission and the parties to re-focus on the core technical issues and the important task of meaningfully implementing the CPM's recommendations. To that end, PanAmSat begins its discussion with a brief overview of the basic technical concepts associated with NGSO/GSO sharing of Ku-band spectrum.

A. Sharing Principles.

It is well known that at Ku- and higher frequency bands, transmission signal strength variability caused by rain attenuation is a significant problem that must be compensated for by GSO networks. The common practice for overcoming rain variability impairment effects is to increase signal transmission power levels – a "rain margin" - so that the resulting reduced (faded) receive signal levels are still high enough for useful communications.

It is also well known that the signal attenuation due to rain is proportional to the rain rate at an earth station site, and that over time the rain rate (and the associated levels of attenuation) will differ for each earth site location. It follows that, because of those differences, different power compensation levels are required for serving different earth station locations.

This phenomenon has been studied for years, and areas of the earth having similar rain climatic conditions have been identified and classified into rain zones. Based upon average yearly rain fall rates, areas of the earth have been divided into Rain Zones A to P, with Rain Zone A being the driest and Rain Zone P being the wettest, as depicted in Figure 1.

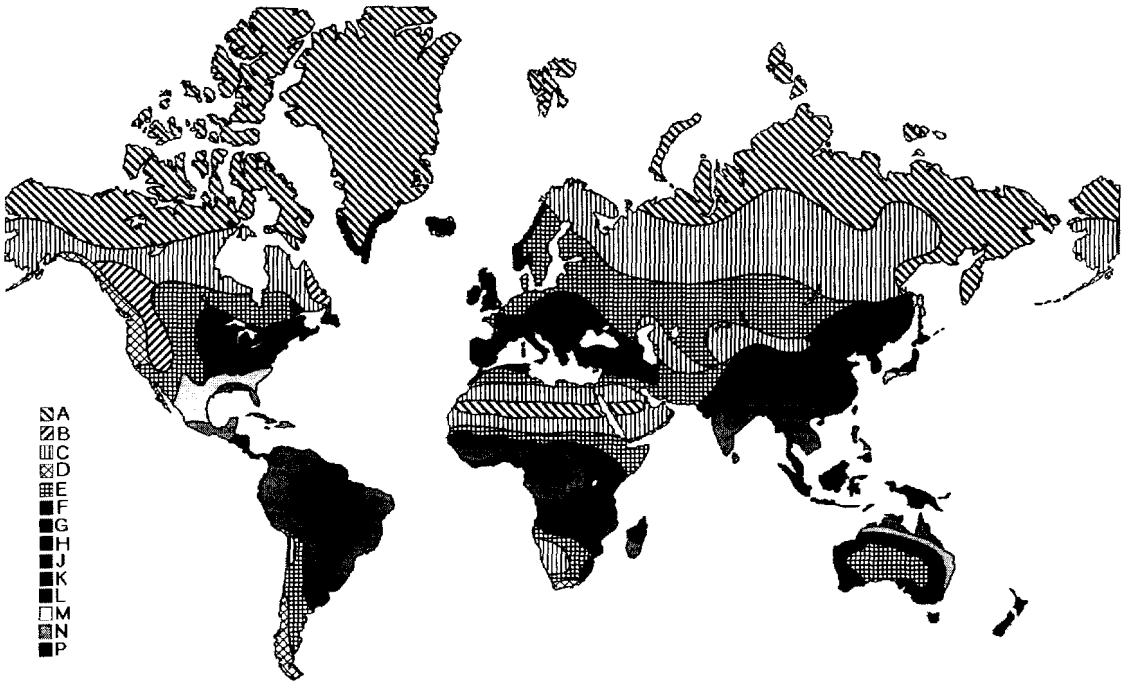

FIGURE 1 - RAIN ZONE AREAS OF THE WORLD

Since only statistical rainfall information can be made available for any particular Rain Zone, it is not possible to determine for any location or area the precise moments in time that additional power compensation for a satellite link will be required. Accordingly, in the case of satellite downlink transmissions, it is common practice for a GSO FSS satellite operator to allocate, and for a GSO FSS satellite to transmit, on a continuous basis, the additional signal power required during rain conditions for the most rain-affected earth station location being served by that satellite transmission. As a consequence of having to transmit permanently that added power, GSO FSS downlink signals always must have a higher received signal strength or carrier to noise (C/N) ratio than is required for acceptable operations during non-rain or clear sky conditions.

This additional margin is the basis of the principle for sharing the Ku-band bands between GSO and NGSO systems. "Successful" sharing is based upon the presumption that NGSO networks can take advantage of the added

power that is present in the GSO FSS downlinks during clear sky (*i.e.*, non-rain) conditions in order to emit potentially interfering signals without actually degrading the GSO FSS signal to an unacceptable level.[5]

The fundamental presumption, simply stated, is that the additional power margin present in the GSO FSS signal may be exploited by the NGSO operator, and will be sufficient to overcome the additional interference caused by the NGSO signal. In more technical terms, successful sharing occurs when the additional interference (I) due to the NGSO signal is always limited so that, during clear sky conditions, the GSO FSS carrier to noise plus interference (C/N+I) ratio received at the GSO FSS earth station receiver is always equal to or greater than the (C/N) ratio originally established for the GSO FSS link during rain conditions. It is also presumed that during rain conditions the NGSO interfering signal would be attenuated by the rain, so that its effect on the faded, but adequate, desired received signal would be minimal.

B. The Problem.

While using a GSO system's rain margins to overcome NGSO interference often will "solve" the problem of NGSO interference, the problem arises because, in many cases, it is not true that $C/(N+I)_{clear\text{-}sky}$ is sufficiently greater than $(C/N)_{rain}$ to overcome NGSO interference. For example, in low precipitation rain zones, the additional GSO power normally supplied to overcome rain effects may be so small that it is inadequate to overcome the NGSO transmitting power requirements during clear sky conditions. Similarly, GSO networks operating with larger earth station antennas,[6] low link noise temperature, and/or at high

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[5] The CPM Report specifically concluded that NGSO networks may not rely on margin provided by a GSO operator for other purposes - for example, to compensate for equipment aging - in order to overcome NGSO interference. CPM Report Section 3.1.2.1.1.

[6] GSO users often choose to avoid paying for expensive satellite transmission power by constructing earth stations with larger antennas. Satellite power and antenna size are

altitudes with little or no "excess" margin[7] all may lack a $C/(N+I)_{clear\text{-}sky}$ value that is sufficiently greater than $(C/N)_{rain}$ to overcome NGSO interference and, therefore, will be particularly sensitive to NGSO interference.[8]

Moreover, as PanAmSat has noted in its comments in this proceeding, virtually all studies of sensitive links have been based solely on existing and planned links. The implementation of future technologies, such as spot beams, advanced modulations, and lower system noise temperatures, however, often will be made more difficult due to GSO operators' obligation to accept the NGSO interference levels envisioned by the CPM compromise.

NGSO systems will operate on a global basis and, by definition, will employ orbits that are not fixed relative to the earth. As a result, one can assume that they will transmit the same power levels into all areas of the earth over which they pass, without regard to the Rain Zone type, altitude, or other characteristics of the area being illuminated by their signal. GSO FSS earth stations in light precipitation rain zones and other "sensitive links," therefore,

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substitutes for one another: Within certain limits, a customer can achieve the desired performance level by combining a larger earth station receive antenna with a lower downlink power, or by combining a smaller earth station receive antenna with a higher downlink power. Because the antenna involves a one-time cost while satellite power involves a continuing cost, many customers employ the former option. GSO users who employ or wish to employ larger diameter antennas now face an additional constraint, because larger antennas have higher gain, making them much more sensitive to NGSO interference than smaller diameter antennas.

[7] "Excess margin" is defined in the CPM Report as "margin above what a link needs to meet its short-term performance objective due to rain." CPM Report Section 3.1.2.1.1. "Excess" margin results from the deliberate allocation of a scarce resource - satellite power - to ensure acceptable performance during worst-case weather conditions.

[8] CPM Report Section 3.1.2.1.1. In some situations, a customer's problems will be compounded by the existence of several of these characteristics at a single earth station location. PanAmSat, for example, has documented situations in which a U.S. customer network operating in a low Rain Zone employs one or more large earth station antennas and has presented information regarding these situations to the Commission and to the ITU-R. For these customers, the interference potential of NGSO systems is particularly acute.

may receive NGSO interfering signals that exceed the buffering effects of the GSO rain margin power compensation that has been provided. During those times when the level of NGSO interference exceeds the available GSO margin (driving the received noise levels above the operating requirements), the interference either may degrade the GSO FSS target operating data bit error rate ("BER") or C/N objectives or, if high enough in level, may cause the GSO FSS link to lose synchronization. While a limited degradation time of the ratio of desired signal to NGSO signal interference may be considered acceptable, synchronization losses are unacceptable because of their disruptive effects.[9]

Much of the earth's surface lies in low rain zone regions. PanAmSat has provided to the ITU-R a number of studies analyzing and identifying, with internationally accepted methodologies, the areas of the world where rain zone conditions could result in satellite link designs that could be adversely affected by NGSO interference.[10]

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[9] A signal destined for an end user generally will have imbedded in it, besides the desired end user information, important auxiliary information that needs to be correctly interpreted and acted upon by various network elements before the signal can be received and interpreted at its final destination. That auxiliary information includes, among other things, information about: the end user address, identifying information about the originating source, the required path routing the signal must take; and end usage special functional directions. Successful interpretation of that information is dependent on the network reception points being synchronized in time and on the auxiliary information appearing in the signal stream sequence at their precise timing location. A signal disruption can destroy that timing relationship and force the network, in effect, to stop the signal transmission until the network can be re-synchronized. Re-synchronization is a complicated and time consuming process and networks, therefore, have been designed to be minimally susceptible to the anticipated environment. NGSO interference adds another dimension to this problem.

[10] See, e.g., ITU-R document CPM_2/138. The Commission should reject claims that PanAmSat's designation of "sensitive links" overstated the number of such links. The Circulars issued by the ITU on the question of sensitive links specifically requested data on these links; in response, PanAmSat supplied data identifying sensitive links, and only sensitive links. The fact that other administrations may have supplied data on a mix of sensitive and non-sensitive links - whether because they interpreted the ITU Circulars differently, because they had not studied NGSO/GSO sharing issues sufficiently to be

Of particular interest to the FCC, the United States has more than 50% of its land area within the dry Rain Zones A, B, C (Alaska), D and E (most of western CONUS). As a result, the problems posed by NGSO transmissions to GSO networks in low Rain Zone areas should not be discounted by the Commission or deferred to other administrations for resolution. It is also noteworthy that the Commission has a statutory obligation to encourage the deployment, on a reasonable and timely basis, of advanced telecommunications capability to all Americans - in particular, rural Americans - as well as a pending rulemaking in which it is seeking to promote the provision of telecommunications services to Tribal Lands and other unserved and underserved areas.[11]

As Figure 1 below illustrates, all of Alaska and virtually all of the western United States lie in relatively dry Rain Zones. Alaska and the west also are areas in which many Tribal Lands and other unserved/underserved areas are located. Thus, there is a direct relationship between the adequacy of the protections provided for GSO networks in dry regions and the cost and reliability of GSO FSS services that can be made available to Tribal Lands and other unserved/underserved locales. If NGSO networks transmit at levels that exceed the low rain margins employed by GSO networks in these sensitive areas, users either will be forced to pay for larger power margins (if additional satellite power is available) or face the risk of service degradations and interruptions.

III. THE CPM AGREEMENT.

After a long and often contentious process, the CPM produced a compromise three-pronged approach for mitigating NGSO interference into GSO

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able to determine which links would constitute sensitive links, or otherwise - does not render PanAmSat's submissions "slanted."

[11] *Telecommunications Act of 1996*, Pub. L. No. 104-104, § 706, 110 Stat. 56 (1996); *Extending Wireless Telecommunications Services to Tribal Lands*, Notice of Proposed Rulemaking, WT Docket No. 99-266, FCC 99-205 (rel. Aug. 18, 1999).

networks. These three mechanisms are intended broadly to assure that NGSO systems will not unduly interfere with GSO systems. Under the compromise, an NGSO system must meet each of the following:

Validation Mask. This mask represents the worst-case statistical interference levels (defined in terms of Equivalent Power Flux Density Limits ("EPFD")) that each NGSO system would be permitted to transmit to the earth's surface. An NGSO system would not be allowed to exceed the validation mask limits under any conditions, at any time. An administration proposing an NGSO system would be required to demonstrate compliance with the validation mask. In addition, there would be an ITU-administered threshold validation test regulating the aggregate interference permitted to a GSO FSS system from all NGSO systems, collectively. The validation test for meeting the mask limits would be administered by the ITU Radiocommunication Bureau ("ITU BR"). The software used to conduct the test would be developed by interested administrations and administered by the ITU.

Operational Mask. This mask represents the maximum statistical interference potential (defined in terms of EPFD) that an NGSO system would be permitted during its lifetime over 100 % of the earth surface, assuming normal conditions. An administration proposing an NGSO system would be required to certify to the ITU that the proposed NGSO system complies with the operational mask. Individual administrations also could use the operational mask as an eligibility standard for authorizing NGSO systems within their national boundaries. The operational mask limits are more stringent than the validation limits; the CPM Report permits individual administrations to demand the higher standard as a matter of national licensing. PanAmSat believes that the FCC should impose this standard as a licensing condition for U.S. applicants and foreign systems wishing to serve the U.S.

Operational Limits. These limits specify the maximum levels of interference (defined in terms of EPFD) that an NGSO system would be permitted to cause to any GSO FSS earth station, at any time. Specific limits vary depending on the size of the GSO FSS earth station and are never to be exceeded by an NGSO system. The intention is to establish maximum levels and to set them out as criteria in the ITU's Radio Regulations. The CPM Report envisions that individual administrations will specify and execute enforcement criteria and

methods to ensure that, if a GSO FSS system operator experiences sync loss when the NGSO system exceeds these levels, steps are taken to reduce the interference levels to meet the criteria.

It should be noted that the CPM99-2 NGSO FSS EPFD masks are single entry limits and were derived from aggregate EPFD masks based on certain assumptions regarding the maximum number of NGSO systems that will be placed into operation.[12] Rules and procedures that will protect GSO FSS systems from aggregate interference, however, have not yet been developed by the ITU-R.[13] While the United States intends to propose a WRC-2000 resolution requesting that the ITU-R develop rules and procedures to protect GSO FSS systems from aggregate NGSO interference, including if the number of effective interfering NGSO FSS systems is greater than 3.5, the Commission cannot proceed to license multiple NGSO systems without first resolving, as a national matter, an appropriate means for assessing and enforcing aggregate interference limits.

IV. BASIC IMPLEMENTATION AND ENFORCEMENT PRINCIPLES.

As noted above, the CPM Report is not self-executing. Even if adopted by WRC-2000, it leaves several important issues open to interpretation. In addition, in many instances it relies on individual administrations to establish and enforce implementing measures. Thus, it is crucial that the Commission not merely "adopt" the CPM Report as the basis for NGSO/GSO FSS sharing in the Ku-band. Rather, the Commission needs to develop specific policies to govern NGSO use of the Ku-band and to incorporate those policies into its Ku-band NGSO licensing process and into binding licensing conditions and technical, service, and licensing rules. The Commission's policies, licensing decisions, and

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[12] Briefly stated, the assumption for "N" is that 3.5 NGSO systems with sharing characteristics equivalent to those of the SkyBridge system will be placed into operation. The actual number of systems may differ from "N", however, depending on the specific characteristics of the NGSO systems that are authorized.

[13] See CPM Report § 3.1.1.3.2.

rules, moreover, should take into account the United States' "unique and extensive use of the Ku-band" by GSO FSS systems.[14]

The following principles should form the cornerstone of the Commission's policies and rules:

- In order to transform the CPM compromise into a meaningful regulatory regime that is adequately protective of GSO networks, the Commission should adopt and enforce a meaningful, pre-licensing process to verify compliance with the operational mask and a prompt, post-licensing process to confirm ongoing compliance with the operational limits.

- In addition, the Commission should ensure that the aggregate limits envisioned by the CPM compromise are reflected in both its Ku-band NGSO licensing decisions and in its ongoing enforcement efforts. In this regard, PanAmSat notes two important considerations. First, the aggregate limits may not accommodate the number of Ku-band NGSO systems for which applications have been filed. Second, aggregate EPFD levels must be calculated from the statistical combination of interference from all licensed NGSO systems, and this calculation must be based on final NGSO system designs. NGSO system designs, however, cannot be finalized until the NGSO applicants have completed their inter-system coordination discussions.

- Finally, the Commission should re-assess, at appropriate times, the progress of the NGSO proponents and ensure that, if these systems are not placed into operation within a reasonable period of time, GSO FSS operators do not continue to be unreasonably burdened by coordination obligations.

PanAmSat's specific implementation and enforcement recommendations are as follows.

1. Implementation of the Validation Mask (CPM Report Section 3.1.2.1.4(c) and S22-1 of Annex 1 to Chapter 3).

The Commission should participate in the development of the ITU software that will be used to measure compliance with the validation mask. It

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[14] *Ku-Band GSO/NGSO Sharing NPRM* at ¶ 11.

should pursue an outcome at the ITU in which: (1) software will be developed quickly; (2) validation will be part of the initial filing process for NGSO systems; and (3) full particulars will have to be provided to the ITU at the outset so that interested administrations independently can confirm compliance. In addition, as part of its role as the notifying administration for U.S.-licensed NGSO systems, the Commission should forward to the ITU the materials from each U.S. applicant needed to demonstrate compliance with the mask.

The ITU will be responsible for evaluating the validation mask. It will review inputs, operate the software, and determine which proposed systems have demonstrated compliance.

As a result, the Commission need not incorporate the validation mask into its rules. Rather, it should impose as a license condition (or, in the case of foreign-licensed systems, as a threshold entry condition) that an NGSO system may not begin operations within the United States, or between the United States and any foreign point, until the ITU confirms, in writing, that the licensee has met the validation mask requirement and the licensee has forwarded this determination to the Commission. This process would be analogous to the Commission's process for ensuring U.S. licensees' compliance with Intelsat Article XIV consultation requirements.

2. Implementation of the Operational Mask (CPM Report Sections 3.1.2.1.4(c) and 3.1.2.4.8 and S22-4A of Annex 1 to Chapter 3).

If GSO FSS systems are to be protected from harmful interference, it is imperative that the Commission adopt strict rules to ensure NGSO compliance – prior to licensing – with the operational mask limits. These limits should be incorporated into the FCC's rules, and compliance with them should be made an express license (or entry) condition.

The importance of the operational mask and the operational limits (discussed below) cannot be overstated. Even if every NGSO system complies with these criteria at all times, PanAmSat is certain that many of its links in the more arid rain zones will be adversely affected by NGSO emissions and will require further protection. In the spirit of compromise, PanAmSat has accepted that burden based upon its belief that the Commission will adopt and strictly enforce the operational mask and limits.[15]

Thus, as discussed below, each NGSO operator should be required to meet the operational limits 100% of the time during normal operation, as required by the CPM Report.[16] In the event an NGSO system experiences "non-normal" operations that cause it to exceed the operational limits, the system should be required to reduce its transmission levels to normal or shut down operation until normal operating limits are re-established

Moreover, the FCC should require each NGSO applicant to demonstrate, prior to licensing, that it will be able to meet the CPM Report's operational masks within the United States. (These limits are shown in Tables 1a and 1b and Figures 1a and 1b.) Since NGSO interference will vary geographically and temporally, the Commission should require each NGSO applicant to provide documentation demonstrating that it will meet the operational masks for both temporal and geographical distributions.

This requirement could be satisfied using software supplied by the NGSO applicant, provided that the NGSO applicant makes available for public

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[15] The FCC's role is important for three reasons. First, because the FCC's rules will govern access to the U.S. market, it is unlikely that an NGSO system - wherever licensed - will feel free to ignore these rules and pay the price of losing access to the U.S. market. Second, PanAmSat believes that the FCC's implementation approach will serve as a regulatory model for the rest of the world's administrations. Finally, if the Commission adopts final rules prior to WRC-2000, its conclusions and interpretations will influence the way the CPM Report is viewed at that conference.

inspection and comment its software source code and all justifications and assumptions employed by the applicant as part of its demonstration. Software verification should include the generation of maps showing maximum NGSO interference power levels that could be received in the United States, as seen by two-degree spaced GSO FSS space stations that can serve the United States. In addition, a software tool should be required of the applicant that would allow the determination of temporal interference statistics for any location within U.S. territorial limits.

The NGSO antenna patterns used to produce the geographic and temporal demonstration should be a 99% confidence bound on the sidelobe levels over the life of the satellite. In addition, since interference into the United States could be caused by traffic to other countries, the Commission should require the demonstration to take into account the global operations of the NGSO system.

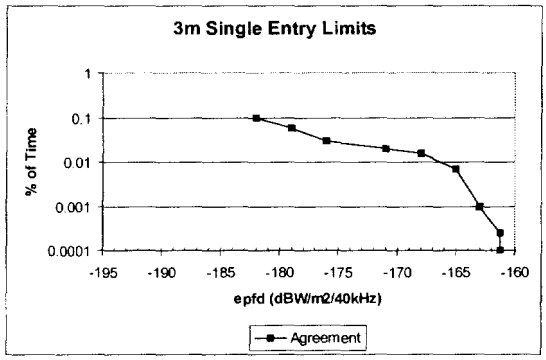
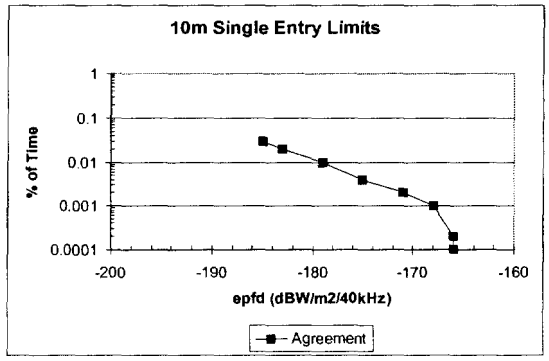


Figure 1a) 3 Meter Operational Limit Mask



1b) 10 Meter Operational Limit Mask

[16] CPM Report at § 3.1.2.1.4.8

Table 1a) 3 Meter Operational Limit Mask Values

EPFD (dbW/M²/40kHz)	% of Time
-182	0.1
-179	0.06
-176	0.03
-171	0.02
-168	0.016
-165	0.007
-163	0.001
-161.25	0.00025
-161.25	0.0

Table 1b) 10 Meter Operational Limit Mask Values

EPFD (dbW/M²/40kHz)	% of Time
-185	0.03
-183	0.02
-179	0.01
-175	0.004
-171	0.002
-168	0.001
-166	0.0002
-166	0.0

2.1 Temporal Operational Limit.

The FCC should require that the temporal operational limit demonstration include a software submission capable of generating an $EPFD_{down}$ cumulative probability density function graph for a specific location of the GSO FSS ground station and longitude of the GSO FSS satellite. The FCC could then test operational limit compliance for any specified test location within the United States corresponding to the GSO longitude.

The software supplied by the applicant should be capable of taking into account the maximum traffic loading distributions and geographic specific scheduling and, once licensed, the Commission should require the NGSO licensee to operate within the bounds of the input parameters. The Commission should require that copies of the software used for the demonstration be filed with it, and should make these copies available for public inspection and comment.

2.2 Operational Limit Map.

Each NGSO applicant should be required to provide a demonstration consisting of a set of maps illustrating the geographic distribution of the maximum $EPFD_{down}$ levels within the United States. Any given location on a

map will show the maximum $EPFD_{down}$ level that can occur at that location. Such presentations would allow GSO FSS operators to determine where their links will require additional protection margin.

The demonstration should take into account the maximum traffic loading distributions and geographic specific scheduling that will meet the operational limits. The Commission should make clear as a licensing condition, in its service rules, or both, that each NGSO applicant will be required to operate within the bounds of these input parameters.

The maps should represent interference levels into GSO FSS earth stations serving specific target GSO FSS satellites, spaced in 2° increments across the visible GSO arc. The maps should show output maximum $EPFD_{down}$ levels with a minimum resolution of 1° longitude by 1° latitude and should envelope all $EPFD_{down}$ levels within that area. Each map should demonstrate that the $EPFD_{down}$ levels are all below the 100% operational limit values.

3. Implementation of the Aggregate Operational Mask Limits (CPM Report Section 3.1.2.1.3 (b))

Each NGSO applicant should be required to provide, prior to licensing, documentation demonstrating that it meets the aggregate operational mask limits. This demonstration should be based on an $EPFD_{down}$ Cumulative Density Function ("CDF") envelope curve that bounds all the $EPFD_{down}$ (CDF) curves used to demonstrate temporal compliance with the operational limit masks (*i.e.* curves representing all the test points). This is illustrated in the plot shown in Figure 2.

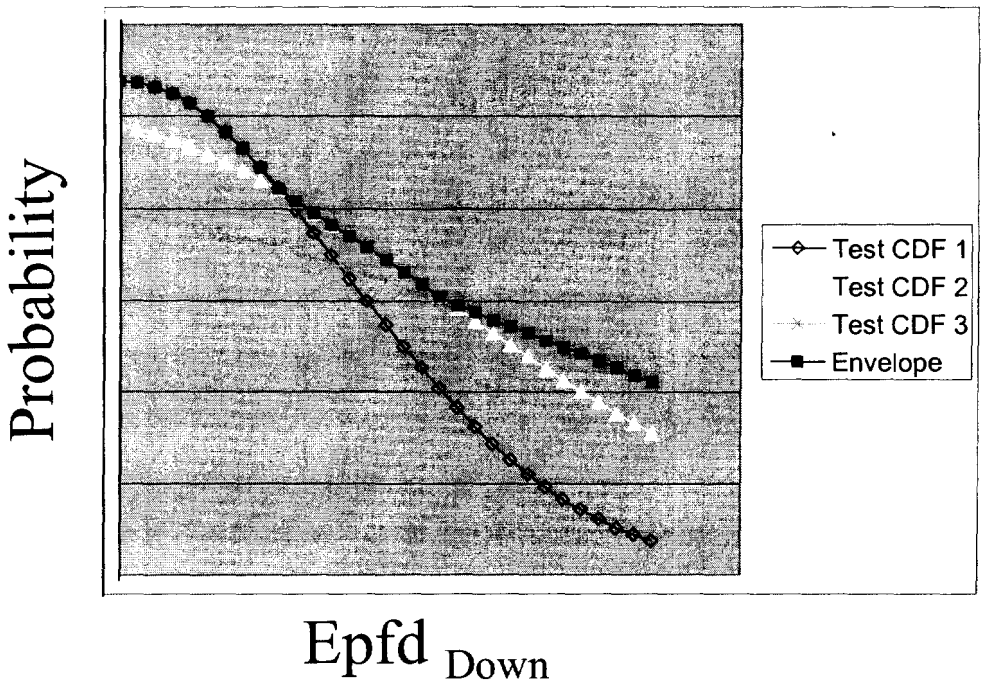


Figure 2: Example $EPFD_{down}$ envelope CDF curve

An aggregate test mask should be calculated based on the convolution of the proposed NGSO system's $EPFD_{down}$ envelope CDF curve with envelope curves from all prior FCC NGSO valid filings. Care should be taken so that this calculation is done accurately (*e.g.* before convolving $EPFD_{down}$ curves must be changed to numeric). The resulting aggregate test mask should not exceed any aggregate $EPFD_{down}$ limit shown in Tables 2a and 2b and Figures 2a and 2b.

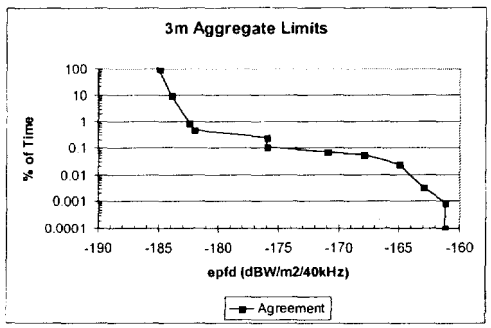
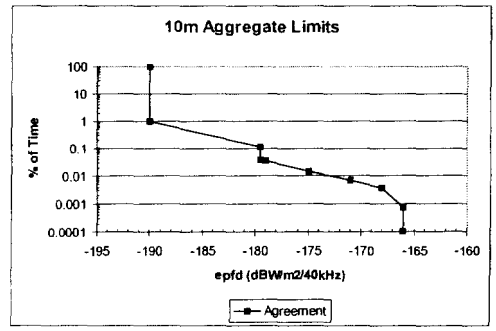


Figure 1a) 3 Meter Aggregate Limit Mask



1b) 10 Meter Aggregate Limit Mask

Table 1a) 3 Meter Aggregate Limit Mask s Values

EPFD (dbW/M²/40kHz)	% of Time
-185	100
-184	10
-182.5	0.9
-182	0.5
-176	0.25
-176	0.105
-171	0.07
-168	0.056
-165	0.0245
-163	0.0035
-161.25	0.000875
-161.25	0

Table 1b) 10 Meter Aggregate Limit Mask Values

EPFD (dbW/M²/40kHz)	% of Time
-190	100
-190	1
-179.559	0.115
-179.559	0.038
-179	0.035
-175	0.014
-171	0.007
-168	0.0035
-166	0.0007
-166	0

4. Implementation of the Operational Limits (Section 3.1.2.4.7 of the CPM Report): Clear, Binding Requirements and Rapid, Reliable Enforcement.

While the operational limits differ from (and are more restrictive than) the validation limits, the CPM Report expressly states that they are binding and may not be exceeded at any time, under any circumstances.[17] These limits were adopted specifically to address the risk of sync loss to larger diameter (≥3 meter)[18] earth stations, and are a crucial part of the CPM compromise. Indeed, PanAmSat remains convinced that the CPM compromise will not protect some existing and planned GSO FSS networks, and it would not have agreed to the compromise had the operational limits not been included. Strict FCC enforcement of these limits (which are set forth in Table 3), therefore, is essential.

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[17] CPM Report at § 3.1.2.4.7(i) (recognizing that the operational limits are more restrictive than the validation limits and stating that an NGSO operator will be deemed to have satisfied its obligations under S.22 only if its $EPFD_{down}$ into operational GSO earth stations as defined in § 3.1.2.1.4 never exceeds the operational limit).

[18] CPM Report at § 3.1.2.1.4(c).

Table 3: Operational limits to the $EPFD_{down}$ radiated by non-GSO FSS systems in certain frequency bands

Frequency band (GHz)	$EPFD_{down}$ dB(W/m^2)	Percentage of time during which $EPFD_{down}$ may not be exceeded	Reference bandwidth (kHz)	Receive GSO earth station antenna diameter[2] (m)	Orbital inclination of GSO satellite (degrees)
10.7-11.7 in all Regions 11.7-12.2 in Region 2 12.2-12.5 in Region 3 and 12.5-12.75 in Regions 1 and 3 (prior to 31 December 2005)	-163	100	40	3	≤2.5
	-166			6	
	-167.5			9	
	-169.5			≥18	
	-160	100	40	3	≤4.5
	-163			6	
	-164.5			9	
	-166.5			≥18	
10.7-11.7 in all Regions 11.7-12.2 in Region 2 12.2-12.5 in Region 3 and 12.5-12.75 in Regions 1 and 3 (after 31 December 2005)	-161.25	100	40	3	≤2.5
	-164			6	
	-165.5			9	
	-167.5			≥18	
	158.25	100	40	3	≤4.5
	-161			6	
	-162.5			9	
	-164.5			≥18	

1 For certain receive earth stations, see also ADD **S9.7A** and ADD **S9.7B**.

2 Linear interpolation of EPFD levels in decibels should be performed for other intermediate antenna diameters.

3 In addition to the operational limits shown in Table **S22-4A**, the additional operational limits in Tables **S22-4A1** and **S22-4A2** apply to certain GSO FSS earth station antenna sizes in the frequency bands listed in Table **S22-4A**.

The CPM Report also states that, if an NGSO system exceeds the operational limits into an operational GSO FSS earth station, the NGSO operator must take "all necessary steps" to resolve the interference "as expeditiously as

possible."[19] In addition, it envisions that individual administrations will determine compliance with and enforce the operational limits.[20] Individual licensing and regulatory bodies - not the ITU - have the ability and authority to act promptly and to require compliance with their dictates.

The operational limits thus should form the cornerstone of the Commission's NGSO rules. The obligation to comply with these limits should be an express condition of each NGSO license (or entry authorization). In addition, in order to make these requirements meaningful, the Commission's rules should ensure that GSO FSS operators and users have: (1) all data necessary to identify the source of an interfering signal in the event of a sync loss; and (2) a rapid, reliable process to ensure that the NGSO system's signal is returned to the proper level.

In order to achieve the first requirement, each NGSO licensee should be required to provide to the Commission, and the Commission should make available to the public, all data necessary to determine the location at any moment in time of each NGSO satellite in the licensee's constellation. For example, the Commission could impose a requirement that each NGSO licensee publish weekly propagating ephemeris data regarding its satellite system. This might be accomplished by requiring each NGSO licensee to submit the weekly information to the FCC electronically, with the FCC re- publishing the information on its web site.

In order to achieve the second requirement, the Commission should adopt a clear, rapid-response mechanism that imposes serious penalties on any NGSO operator who fails to meet the operational limits and to cure a shortfall upon notice. PanAmSat proposes the following. Each NGSO licensee would be

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[19] CPM Report at § 3.1.2.4.7(iii).
[20] CPM Report at §§ 3.1.2.4.7(ii), (iv).

required to designate (and maintain) a contact point for interference disputes involving GSO networks. In the event of interference, a GSO FSS operator or user could make a *prima facie* case that an NGSO system has exceeded the operational limits, shown in Table 3, by submitting the following evidence to an NGSO operator (with a copy to the Commission):

1. Documentation showing that a GSO FSS earth station facility experienced an unexplained loss of signal.[21]

2. Documentation showing that the recorded time period for the loss of signal corresponded to a geometric configuration of an NGSO satellite in the operator's network, as to which EPFD levels could be near their peak level. For LEO systems this will occur when the NGSO satellite passes through the main lobe of the GSO FSS ground station antenna. The location of the NGSO spacecraft would be determined based upon data provided by the NGSO operator (*e.g.*, weekly published, on the FCC web site, propagating ephemeris data). It is expected that simulation orbit propagation errors would be taken into account when making a determination of this time period.

3. Documentation demonstrating that the affected link could only have a loss of signal due to NGSO interference if the operational limits are exceeded. It is expected that this will include an appropriate link budget calculation including all relevant parameters. (This documentation need not rule out other sources of interference but, rather, should show that the link margin is sufficient to overcome NGSO transmissions at the operational limits.)

Upon receiving the above documentation, the NGSO operator would be obligated to engage in immediate corrective action, to reduce emissions to the required levels pending final determination of solutions to the problem, and to

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[21] This documentation could consist, for example, of a network control computer printout or a statement from a network operations center operator. Given the extraordinarily small probability that a sync loss would occur as a result of an unrelated factor during the few seconds that the NGSO satellite was within view of the earth station, a single sync loss episode should be sufficient to trigger remedial action by the NGSO operator.

notify the FCC and the complaining party, within 24 hours, of the corrective action taken. PanAmSat is cognizant of the possibility of disputes arising from this approach and recognizes that one possible method for resolving those disputes would be taking measurements. PanAmSat has given some thought to that approach but has concluded that a measurement process would be highly impractical if not impossible.

We believe that for a measurement process to have any possibility of working, it would require that the NGSO networks be mandated to carry full power identifying beacon signals in each of their beams. Such a requirement would be quite burdensome to NGSO operators. We also believe that the necessary GSO measurement equipment and process would have to incorporate antennas of a size equivalent to that of the complainant earth station, which would require bringing to the affected site the needed antenna or connecting the existing site antenna into the measurement process. The former would not be practical, especially in the case of 10 meter earth station sites, and the latter approach would be disruptive to the station's normal operation due to calibration and testing requirements. Considering the problems that are associated with a measurement process, PanAmSat recommends that the FCC establish an industry advisory group to develop an appropriate procedure for addressing disputes.

In any event, if, at the end of the initial 24-hour period, either party is not satisfied with the corrective action taken by the NGSO operator (*i.e.*, if the complaining party believes that additional action is required, or if the NGSO operator believes that lesser measures would be adequate as a long-term solution), that party may notify the Commission and the other party of this fact. If this occurs, both parties should be required to negotiate, in good faith, for 30 days and to report to the Commission at the end of the 30-day period the results of those negotiations. Commission intervention would be required only if the

parties failed to resolve the matter privately. Penalties could be imposed against any party that the Commission concludes has failed to negotiate in good faith.

If the number of operational limit violations by an NGSO network exceeds six events within any twelve-month period, then the NGSO operator should be required to reduce transmit power levels globally in all locations that can cause interference into the United States. In this way the NGSO operator can guarantee that all affected GSO FSS earth stations will be simultaneously protected. Moreover, repeated violations should subject the NGSO licensee to all other penalties within the Commission's power, including forfeitures and, in extreme cases, license (or market access) revocation.

5. An End to Uncertainty.

In many cases, the mere prospect of NGSO operations in the Ku-band will force GSO FSS operators and users to modify network designs to account for the potential future presence of NGSO signals. Generally, this will be done by providing each potentially sensitive link in a network with a higher link margin than otherwise would have been used. In most cases, this will be achieved by allocating additional satellite power to the affected link(s). Because satellite power is a finite good, the allocation of additional power involves substantial additional cost to GSO FSS operators and users. Currently, it is estimated that links designed to properly operate in the Western U.S. rain zones will have to include additional margins as indicated in the following table. The table is based on the assumption that the protection limits are strictly observed; if they are diluted in any way, or if strict compliance cannot be expected, additional protection would be required.

ESTIMATED ADDITIONAL MARGIN REQUIREMENTS

Antenna Diameter (m)	Operational limits after 2005 (dBw/m2/40 KHz)	Rain Zone B (dB)	Rain Zone D (dB)	Rain Zone E (dB)
3	-161.25	1.75	0	0
6	-164	1.5	0.5	0
9	-165.5	3	2.5	2.0

With regard to PanAmSat satellites serving the United States, a preliminary estimate indicates that about 30% of served earth stations with antenna sizes greater than 3 meters operate in the Western low Rain Zone regions.

It is obvious from that analysis that the additional margins required would be significant in terms of cost impact. Moreover, in most cases, the additional margin must be incorporated when the network is designed and implemented rather than when the NGSO system begins operation. If an operator or user tries to "add" margin only when the NGSO systems begins operations, there may not be additional satellite power available, or existing earth station equipment may not be appropriate for the higher-margin network.

Given these circumstances, delays in the implementation of NGSO systems can be devastating, because such delays prolong the uncertainty for GSO FSS operators as to how to configure their systems, sometimes with irrevocable consequences. Satellite power is a wasting asset: for every day that it is allocated to provide excess margin to overcome potential NGSO interference, the opportunity to use it for a productive purpose is lost.

Accordingly, the Commission should impose strict, relatively short-term construction, launch and operation milestones on each NGSO licensee, and it should not grant milestone extensions absent extraordinary circumstances. Delays arising from financing activities - including license transfer proceedings - or from system alterations should not justify milestone extensions.

Moreover, if any NGSO license is forfeited, relinquished, or otherwise becomes invalid, the Commission should not presume that another NGSO system should be licensed in the former licensee's stead. Were this to take place, GSO FSS operators and users would have to continue designing their networks around the eventual possibility of co-frequency NGSO operations throughout a

potentially long re-licensing process. If and when these circumstances arise, therefore, the Commission should consider whether the public interest would best be served by returning operational flexibility to GSO system operators and users and declining to license additional NGSO systems.

Respectfully submitted,

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APPENDIX 1 - ITU DOCUMENTS

CPM DOCUMENTS

- **Chapter 3 ("Non-GSO FSS Issues") of the CPM Report** on technical, operational, and regulatory/procedural matters to be considered by the 2000 World Radiocommunication Conference, Geneva, 1999 (the "CPM Report").

- Selected contributions to the CPM:

  - **CPM99-2/39** (Proposals for the conference preparatory meeting)
  - **CPM99-2/125** (Loss of synchronization due to NGSO interference)
  - **CPM99-2/126** (Intelsat proposals for modifications to the CPM Report chapter 3)
  - **CPM99-2/134** (Proposed changes to section 3.1.2.3.2 b) of the CPM text based on analysis of BR software assumptions)
  - **CPM99-2/135** (A study of the number of possible GSO FSS link ground station synchronization loss events per year that may be caused by interference from NON-GSO Systems with an FSAT-MULTI 1B configuration)
  - **CPM99-2/136** (An analysis of F-SAT-MULTI-1B interference to GSO ground terminal EPFD level distributions and proposed modifications to sections 3.1.2.4.6 and 3.1.5.1 of the CPM text)
  - **CPM99-2/137** (Proposed changes to section 3.1.2.3.2 b) of the CPM text based on analysis of environmental and other effects on NON-GSO antenna side-lobe levels)
  - **CPM99-2/138** (EPFD levels that can cause sync loss of Ku-band FSS GSO satellite networks)
  - **CPM99-2/139** (Proposed changes to section 3.1.2.3.2 b) of the CPM text based on analysis of the geometric distribution of NON-GSO interference)
  - **CPM99-2/140** (Analysis of the Ku-band 0.6 and 1.2 meter BSS/FSS EPFD masks on GSO FSS earth stations)
  - **USCPM99-2/42** (A criterion for the allowable incremental increase in the number of sync loss events due to NGSO interference)

STUDY GROUP 4 DOCUMENTS

- **4/69r2** (Draft revision of Rec. ITU-R S.1323 - Maximum permissible levels of interference in a satellite network (GSO/FSS; non GSO/FSS; non-GSO/MSS feeder links) in the fixed-satellite service caused by other codirectional networks below 30 GHz)

- **4/67** (Draft new Recommendation ITU-R S[IAL] - Apportionment of the allowable error performance degradations to fixed-satellite service hypothetical reference digital paths arising from time invariant interference for systems operating below 15 GHz)
- **4/64r1** (Draft mod. to Rec. ITU-R S.1257 - Analytical method to calculate short-term visibility and interference stats for non-geostationary satellite orbit satellites as seen from a point on the earth's surface)
- **4/61r1** (Draft revision to Rec. ITU-R S.1325 - Simulation methodologies for determining statistics of short-term interference between co-frequency, co-directional NGSO fixed-satellite service (FSS) networks and other non-GSO FSS or GSO FSS networks)

JTG 4-9-11 DOCUMENTS

- **4/74** (**Chairman's Report** of the May 1999 JTG 4-9-11 meeting, Geneva)
- Selected contributions to the May 1999 JTG 4-9-11 meetings:
  - **JTG 4-9-11/381** (Text for section 3.1.2.1 of the conference preparatory meeting report to WRC-2000)
  - **JTG 4-9-11/384** (Draft element for CPM-99 report)
  - **JTG 4-9-11/394** (Considerations of 10.7-12.75 GHz $EPFD_{down}$ limits)

- **JTG 4-9-11/367** (**Chairman's Report** of the January 1999 JTG-4-9-11 meeting, Long Beach)
  - Selected contributions to the January 1999 JTG 4-9-11 meeting:
    - **JTG 4-9-11/284** (Reference radiation pattern of NGSO FSS satellites for use in generation of downlink PFD masks)
    - **JTG 4-9-11/290** (Methodology to establish protection limits in resolution 130 bands for GSO networks sharing spectrum with NGSO networks)
    - **JTG 4-9-11/342** (Proposed resolution 130 provisional EPFD and APFD limits in the resolution 130 14/11GHz bands)
  - **JTG 4-9-11/211** (**Chairman's Report** of the June1998 JTG 4-9-11 meeting, Toulouse) (including corrigendum)

WP 4A DOCUMENTS

- **4A/422** (**Chairman's Report** of the April-May 1999 WP 2A meeting, Geneva)

- Selected contributions to the April-May 1999 WP 4A meeting:

  - **4A/259** (Draft new recommendation Maximum allowable error performance and availability degradations to digital fixed satellite service hypothetical reference digital paths arising from interference)
  - **4A/279** (US proposed Aggregate EPFD $_{DWN}$ Mask for KU and KA band)
  - **4A/281** (An evaluation of EPFD masks (JTG/TEMP/92) to protect GSO networks in bands below 30 GHz from NGSO sources of interference sharing the same spectrum)
  - **4A/284** (Proposed revision to preliminary draft new recommendation proposed methodologies for calculating suitable NGSO EPFD and APFD levels necessary to meet acceptable unavailability criteria by means of I/N ratios)
  - **4A/289** (Working document towards a proposed draft new recommendation methodology for performing parametric interference studies of globally distributed GSO FSS networks sharing spectrum with NGSO systems)
  - **4A/308** (Proportion of GSO FSS links to be protected from interference from NON-GSO FSS networks)
  - **4A/317** (Simulation results between GSO FSS systems and two newly proposed KU-band NON-GSO FSS systems)
  - **4A/320** (Working document toward a draft new recommendation protection of fixed satellite service networks using slightly-inclined Geostationary Satellite Orbits)
  - **4A/326** (Proposed modifications to recommendation ITU-R 1323)
  - **4A/327** (Working document towards a preliminary draft new recommendation methods for NON-GSO FSS systems to enhance sharing with GSO FSS systems in the frequency bands between 10 and 30 GHz)
  - **4A/329** (Working document towards preliminary draft new recommendation: A method for evaluating EPFD limits for services whose availability are sensitive to synchronization timing recovery in the KU band)

- **4A/362** (Aggregation on interference from multiple NON-GSO FSS systems into GSO FSS systems operating in the 10.7 to 12.75 GHz band)
- **4A/371** (Impact of loss of synchronization on GSO transmissions)
- **4A/391** (Preliminary draft new recommendation considerations for hypothetical reference digital paths when implemented for providing services whose availability are sensitive to synchronization timing recovery)
- **4A/397** (Protection of GSO inclined orbit operation from interference caused by NON-GSO systems)
- **4A/400** (Proposed NON-GSO FSS EPFD limits to protect GSO FSS carriers in the 14/11 GHz band)
- **4A/403** (Proposed modifications to the preliminary draft revision of recommendation ITU-R S.1323)
- **4A/405** (Reference earth station antenna pattern for use in calculating interference from NGSO systems into GSO FSS networks)

JWP 10-11S DOCUMENTS

- **11/167** (**Chairman's Report** of the October 1999 meeting of JWP 10-11S, Geneva)

- Selected outputs from the October 1999 JWP 10-11S meeting:

  - **10-11S/225** (Proposed clarifications and editorial amendments to draft new recommendation: "Functional description to be used in developing software tools for determining conformity of NON-GSO FSS networks with limits contained I Article S22 of the radio regulations")
  - **10-11S/226** (Proposed reply liaison statement to working party 3M concerning uplink and downlink modeling of rain and cloud attenuation for GSO BSS systems)

- **10-11S/209** (**Chairman's Report** of the May 1999 meeting of JWP 10-11S, Geneva)